International Centre for
Indoor Environment and Energy

European Directive for Energy Performance of Buildings and Related CEN-Standardisation

Professor Bjarne W. Olesen, PhD,
Fellow
Director

www.ie.dtu.dk

Technical University of Denmark

DIRECTIVE (Art.1)

The objective of this Directive is to promote the improvement of the energy performance of buildings within the Community, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness.

DIRECTIVE (Art.2)

Energy performance of a building

- **The amount of energy actually consumed or estimated to meet the different needs associated with a standardised use of the building.**
- **This may include, *inter alia*,**
  - **heating**
  - **hot water heating**
  - **cooling**
  - **ventilation**
  - **lighting.**
- **This amount shall be reflected in one or more numeric indicators which have been calculated, taking into account:**
  - **insulation**
  - **technical and installation characteristics,**
  - **design and positioning in relation to climatic aspects**
  - **solar exposure**
  - **influence of neighbouring structures**
  - **own-energy generation**
  - **other factors, including indoor climate, that influence the energy demand**

DIRECTIVE (Art.2)

Energy performance certificate of a building

- **A certificate which includes the energy performance of a building calculated according to a methodology based on the general framework set out in the Annex**

DIRECTIVE (Art.3)

The energy performance of a building shall be expressed in a transparent manner and may include a CO2 emission indicator.

DIRECTIVE (Art.4)
Setting of energy performance requirements

- **These requirements shall take account of general indoor climate conditions, in order to avoid possible negative effects such as inadequate ventilation,**

- **When setting requirements, Member States may differentiate between new and existing buildings and different categories of buildings.**

DIRECTIVE (Art.5)
New buildings

For new buildings with a total useful floor area over 1 000 m2,
Member States shall ensure that the technical, environmental
and economic feasibility of alternative systems such as:
— decentralised energy supply systems based on renewable energy,
— CHP,
— district or block heating or cooling, if available,
— heat pumps, under certain conditions,
is considered and is taken into account before construction starts

DIRECTIVE (Art.7)
Energy performance certificate

- **Member States shall ensure that, when buildings are constructed, sold or rented out, an energy performance certificate is made available to the owner or by the owner to the prospective buyer or tenant, as the case might be.**

- **The validity of the certificate shall not exceed 10 years.**

DIRECTIVE (Art.7)
Energy performance certificate

- **Member States shall take measures to ensure that for buildings with a total useful floor area over 1 000 m2 occupied by public authorities and by institutions providing public services to a large number of persons and therefore frequently visited by these persons an energy certificate, not older than 10 years, is placed in a prominent place clearly visible to the public.**

- **The range of recommended and current indoor**

DIRECTIVE (Art.11)

- **The dissemination to the public of this information on energy performance should be enhanced by clearly displaying these energy certificates.**

- **Moreover, the displaying of officially recommended indoor temperatures, together with the actual measured temperature, should discourage the misuse of heating, air-conditioning and ventilation systems.**

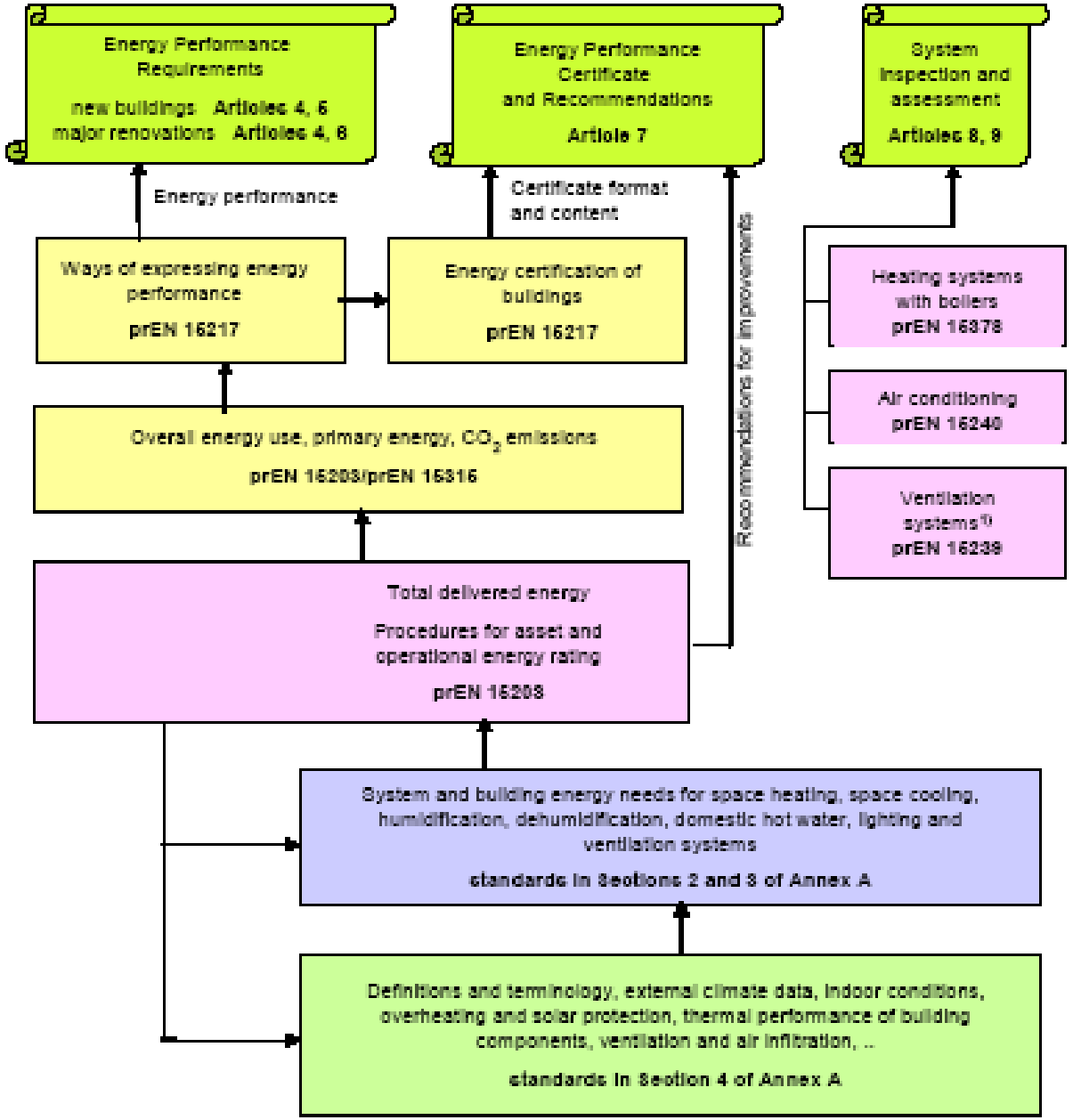
- **This should contribute to avoiding unnecessary use of energy**
and to safeguarding comfortable indoor climatic conditions
(thermal comfort) in relation to the outside

NEW MANDATE FROM EU

- **The standards under the mandate shall thus constitute an integrated and interacting methodology for the calculation of the energy uses and losses for heating and cooling, ventilation, domestic hot water, lighting, natural lighting, passive solar systems, passive cooling, position and orientation, automation and controls[1], and auxiliary installations necessary for maintaining a comfortable indoor environment[2].**
- **[1] The effect on energy performance of automation and controls will be included in each system`s performance instead of being treated as a separate system.**
- **[2] Consideration should also be given to the possibility of several different levels of indoor climate.**

NEW MANDATE TO CEN FROM EU

- **Directive was implemented by January 2006; but still not in all countries and not 100%**
- **Mandate covers more than 31 work items**
- **prEN's (CEN draft standards) have been or are out for 6 months enquiry.**
- **Final standards must be available spring 2007**

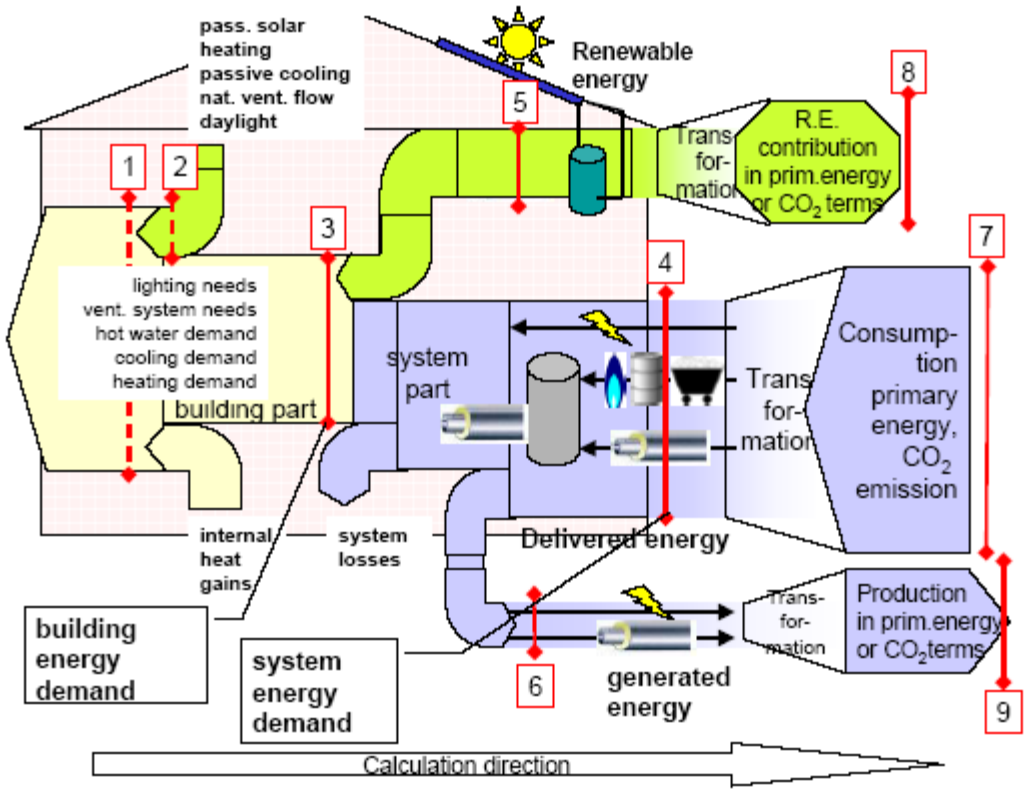

Energy Performance Requirements
new buildings Articles 4, 6
major renovations Articles 4, 6
Energy Performance Certificate and Recommendations
Article 7
System Inspection and assessment
Articles 8, 9
Energy performance
Certificate format and content
Recommendations for improvements
Ways of expressing energy performance
prEN 16217
Energy certification of buildings
prEN 16217
Heating systems with boilers
prEN 16378
Air conditioning
prEN 16240
Ventilation systems1)
prEN 16239
Overall energy use, primary energy, CO_2 emissions
prEN 15203/prEN 15316
Total delivered energy
Procedures for asset and operational energy rating
prEN 15203
System and building energy needs for space heating, space cooling, humidification, dehumidification, domestic hot water, lighting and ventilation systems
standards in Sections 2 and 3 of Annex A
Definitions and terminology, external climate data, indoor conditions, overheating and solar protection, thermal performance of building components, ventilation and air infiltration, ..
standards in Section 4 of Annex A

1) Not explicitly mentioned in the Directive

2) Unless covered by other standards

- **The indicative content of the energy performance certificate is set out in prEN 15217.**
- **prEN 15203 provides ratings to define energy performance. The categories for the purposes of certification are:**
  - **asset rating, based on calculated energy use under standardised occupancy conditions;**
  - **operational rating, based on metered energy.**

Figure 2



Key to symbols

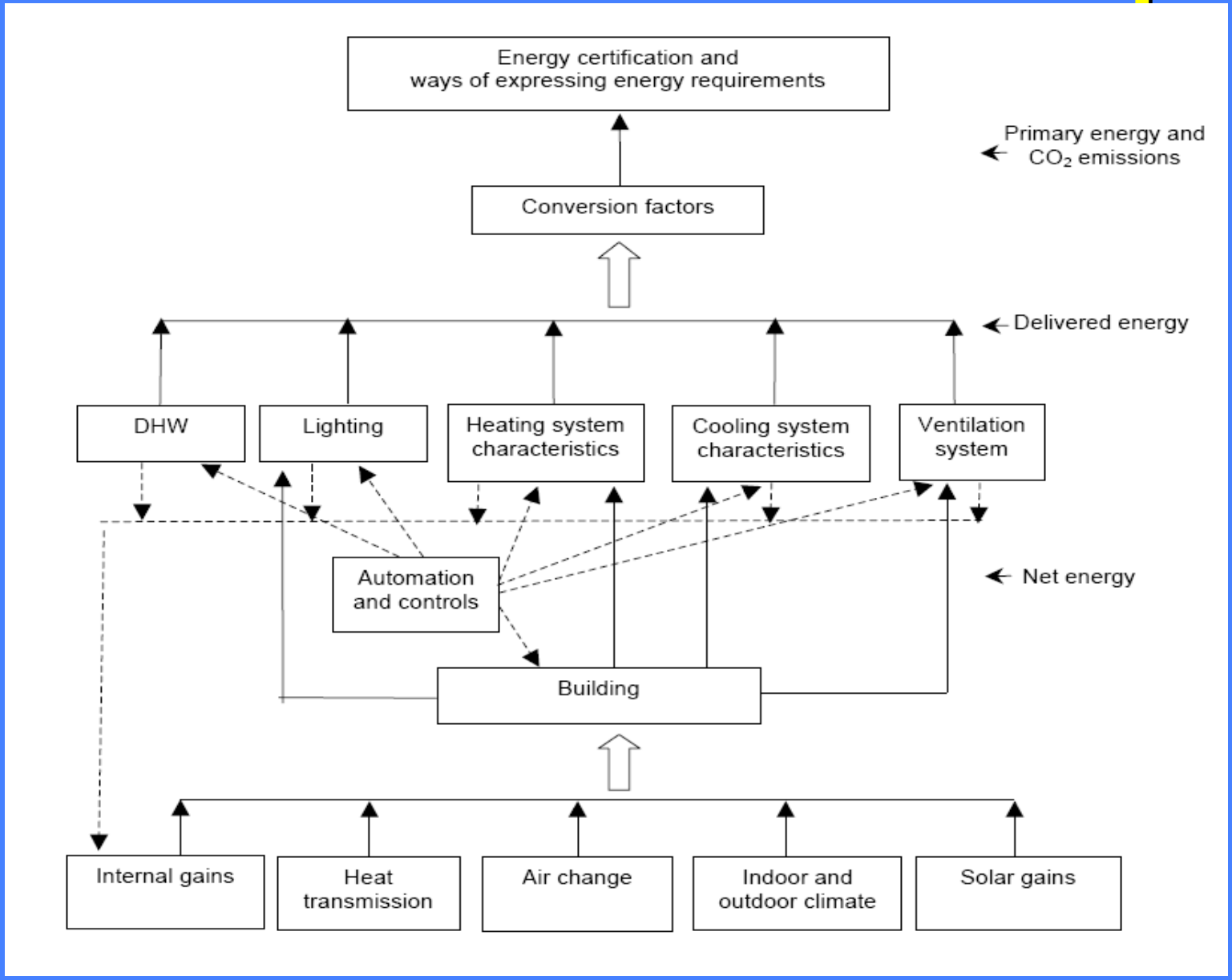
electricity

gas, oil, coal, etc

heat, cold

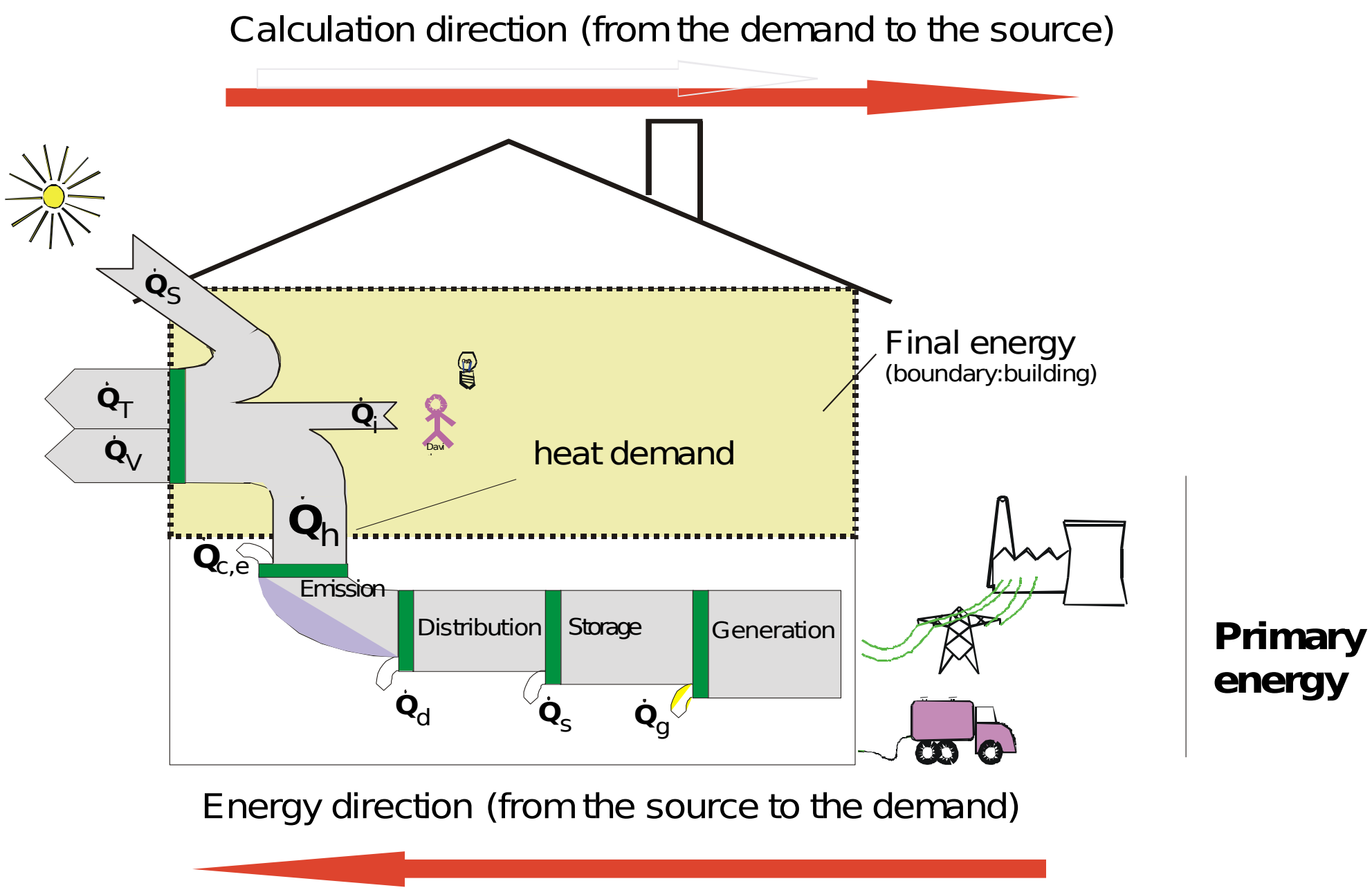
No	Work item	prEN	TC/WG
1. +3	Energy performance of buildings - Methods for expressing energy performance and for energy certification of buildings	15217	89/4
2.	Energy performance of buildings – Overall energy use, primary energy and CO_2 emissions	15315	228/4
3.	Energy performance of buildings – Application of calculation of energy use to existing buildings	15203	89/4
5.	Energy performance of buildings – Systems and methods for the inspection of boilers and heating systems.	15xxx	228/4
6	Energy performance of buildings – Guidelines for the inspection of air-conditioning systems	15240	156/10

Calculation Concept



Calculation Methodology

- The calculation methodology is used to determine the data for energy certificates. prEN ISO 13790 allows for different levels of complexity,
  - Simplified hourly calculation;
  - Simplified monthly calculation;
  - Detailed calculations;
- The calculations are based on specified boundary conditions of indoor climate (prEN 15251) and external climate.
- The simplified calculation methods are fully specified in the prEN ISO 13790.
- The detailed calculation method is not, but any implementation must be validated according to the criteria in prEN 15265.

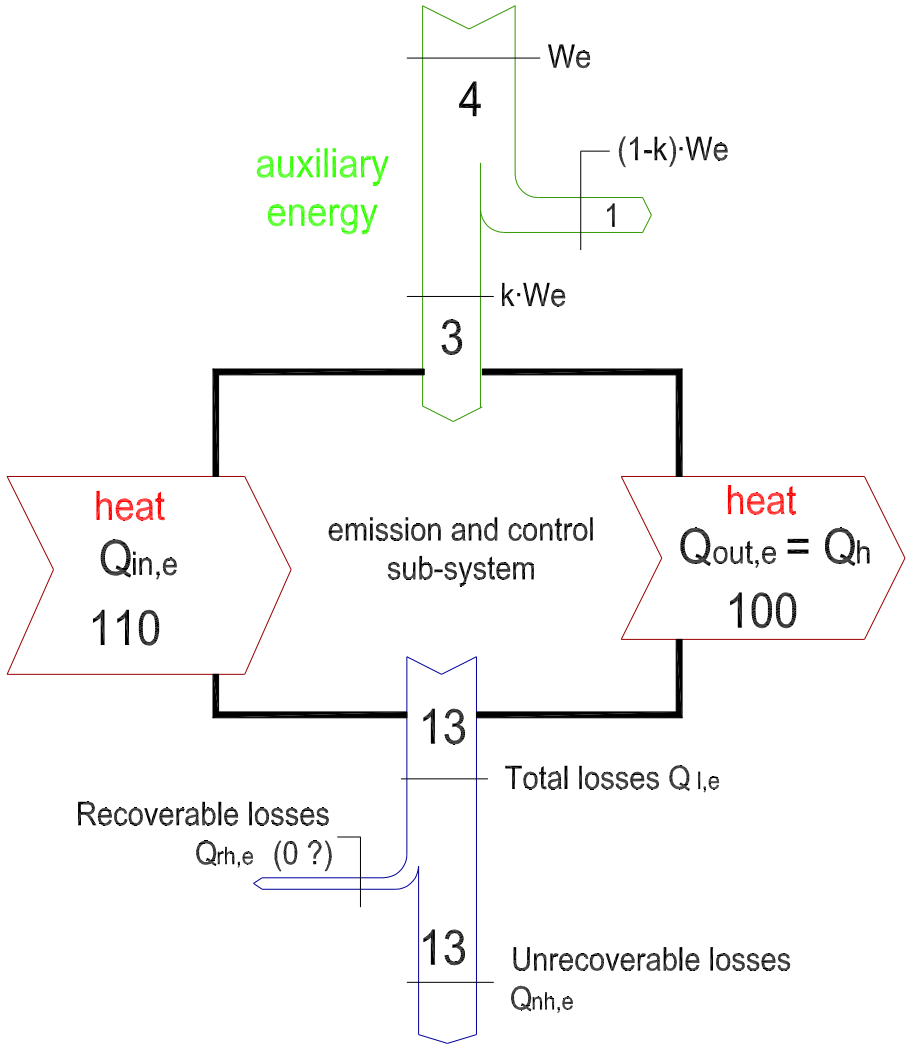

Calculation direction (from the demand to the source)
$\dot{Q}_S$
$\dot{Q}_T$
$\dot{Q}_V$
$\dot{Q}_i$
$\dot{Q}_h$
$\dot{Q}_{c,e}$
heat demand
Final energy
(boundary:building)
Emission
Distribution
Storage
Generation
$\dot{Q}_d$
$\dot{Q}_s$
$\dot{Q}_g$
Primary energy
Energy direction (from the source to the demand)

CEN concept for Heating Systems

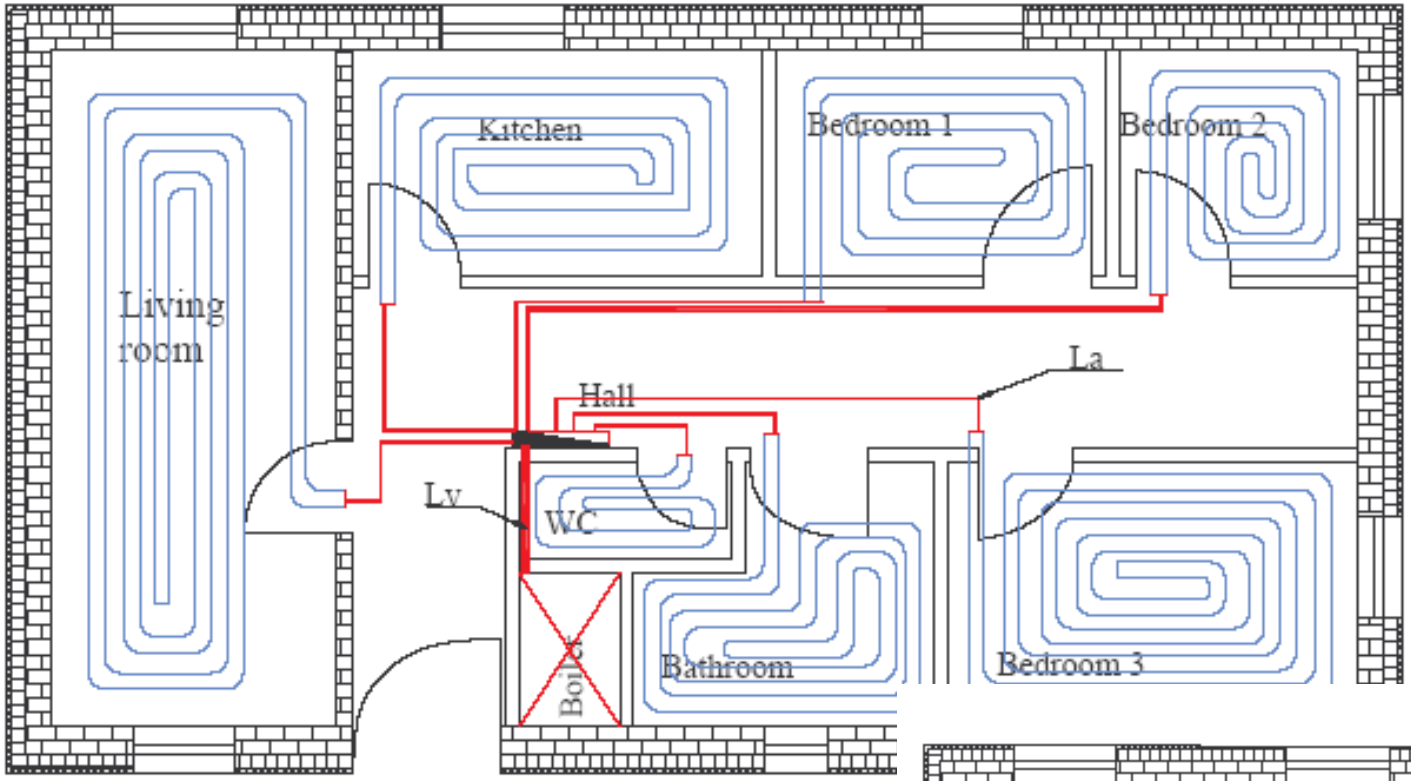
- **Heat emission**
  (radiator, floor heating, warm air etc. including control)
- **Heat distibution**
  (circulation pumps, pipe work)
- **Heat generation**
  (boiler, heat pump, solar etc)

No.	Work item	prEN	TC/WG
7.	Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 1: General	15316-1	228/4
8.	Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 2: Space heating emission systems	15316-2	228/4
9.	Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies for space heating generation systems: Part 4.1.Combustion systems (Boilers) Part 4.2. Heat pump systems Part 4.3. Thermal solar systems (including DHW) Part 4.4 The performance and quality of CHP electricity and heat (incl. on-site and micro-CHP). Part 4.5. The performance of quality district heating and large volume systems. Part 4.6. The performance of other renewable heat and electricity. Part 4.7. Biomass combustion systems	15316-4.1 15316-4.2 15316-4.3 15316-4.4 15316-4.5 15316-4.6 15316-4.7	228/4
10.	Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 5: Space heating distribution systems	15316-5	228/4
11.	Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 3.1 Domestic hot water systems, characterisation of needs (tapping requirements) Part 3-2: Domestic hot water systems, distribution Part 3-3: Domestic hot water systems, generation.	15316-3.1 15316-3.2 15316-3.3	228/4

CALCULATION OF THE YEARLY ENERGY CONSUMPTION FOR HEATING : EMISSION SYSTEM

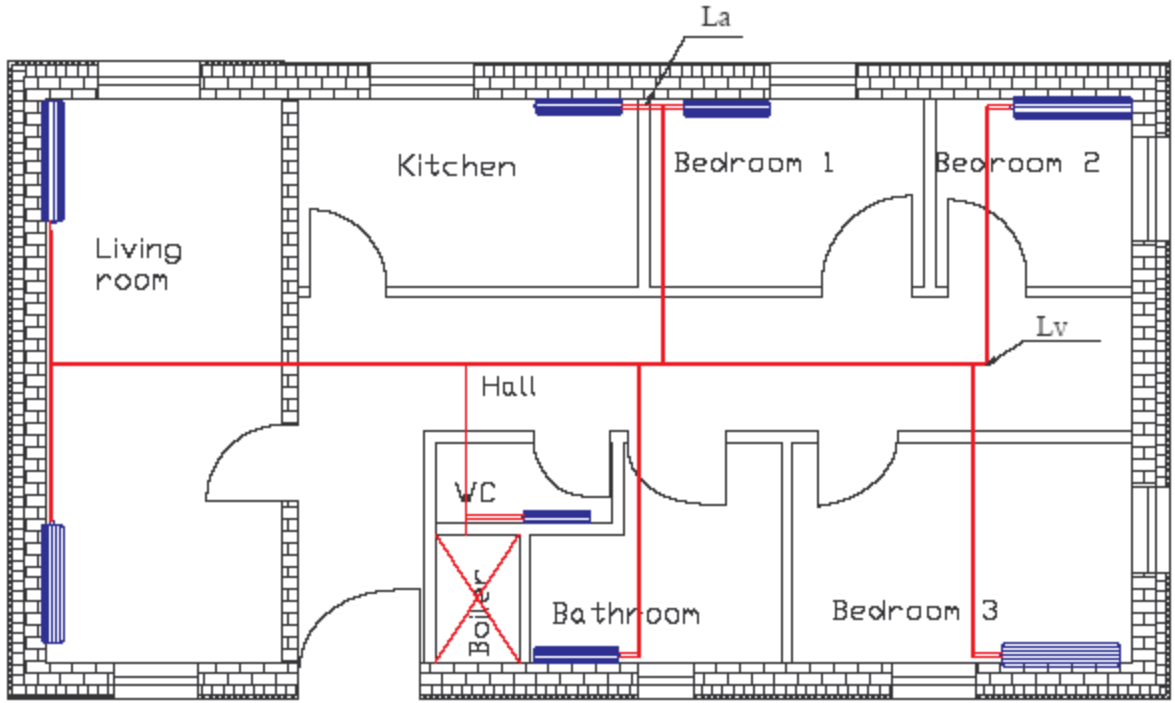


Q_h calculated according to ISO-EN 13790 (EN832) "Calculation of energy use for hea



FLOOR HEATING

RADIATORS



CALCULATION OF THE YEARLY ENERGY CONSUMPTION FOR HEATING : EMISSION SYSTEM

- 1. Non-uniform space temperature distribution
- 2. Emitters embedded in the building structure
-
- 3. Control

CALCULATION OF THE YEARLY ENERGY CONSUMPTION FOR HEATING : EMISSION SYSTEM

1.1.1 Method using control efficiency, η_{ce}

If the control efficiency is given, the heat loss due to the control system, Q_c can be calculated as:

$$Q_{ce} = \frac{1 - \eta_c}{\eta_c} Q_h \quad \text{[J]} \quad (16)$$

where:

η_c **control efficiency**

Annex B is listing examples of values for η_c .

Method using temperature increase

The internal temperature is increased by:

- the spatial variation du to the stratification, depending on the heating system,
- the temporal variation depending on the capacity of the control device to assure a homogeneous and constant temperature.

The internal temperature θ_i, taking into account the heating system, is calculated by the following formula:

$$\theta_i = \theta_{ii} + \delta\theta_{vs} + \delta\theta_{vt} \qquad ( )$$

with:

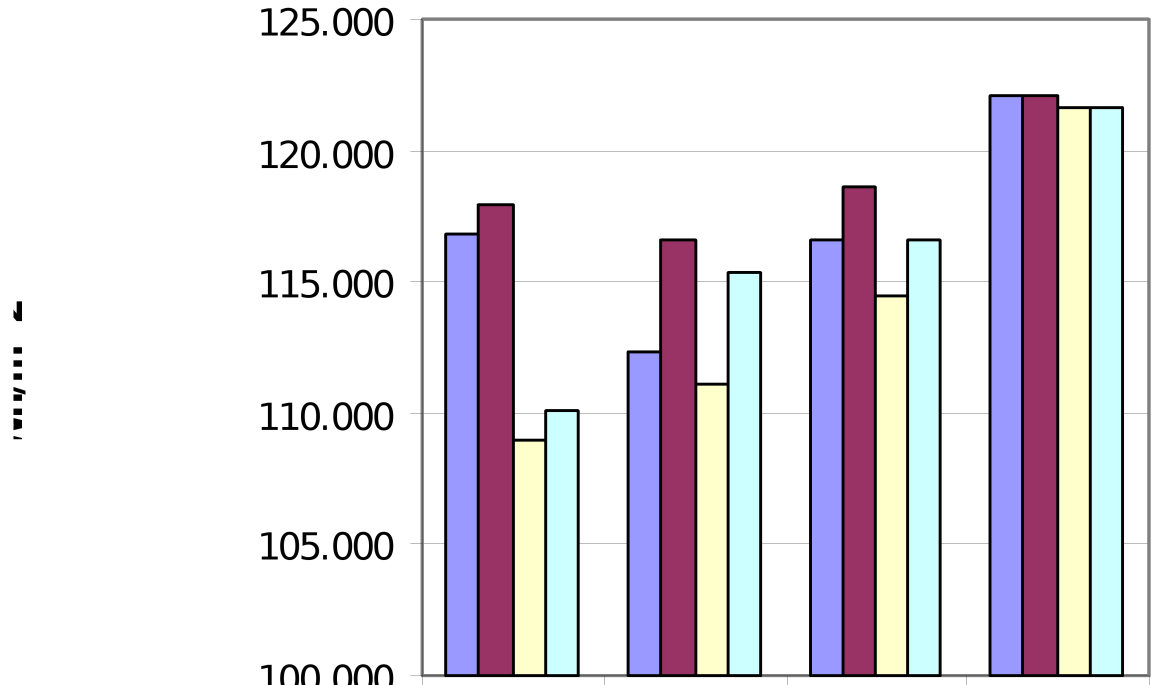
θ_{ii} initial internal temperature,

$\delta\theta_{vs}$ spatial variation of temperature,

$\delta\theta_{vt}$ temporal variation of temperature.

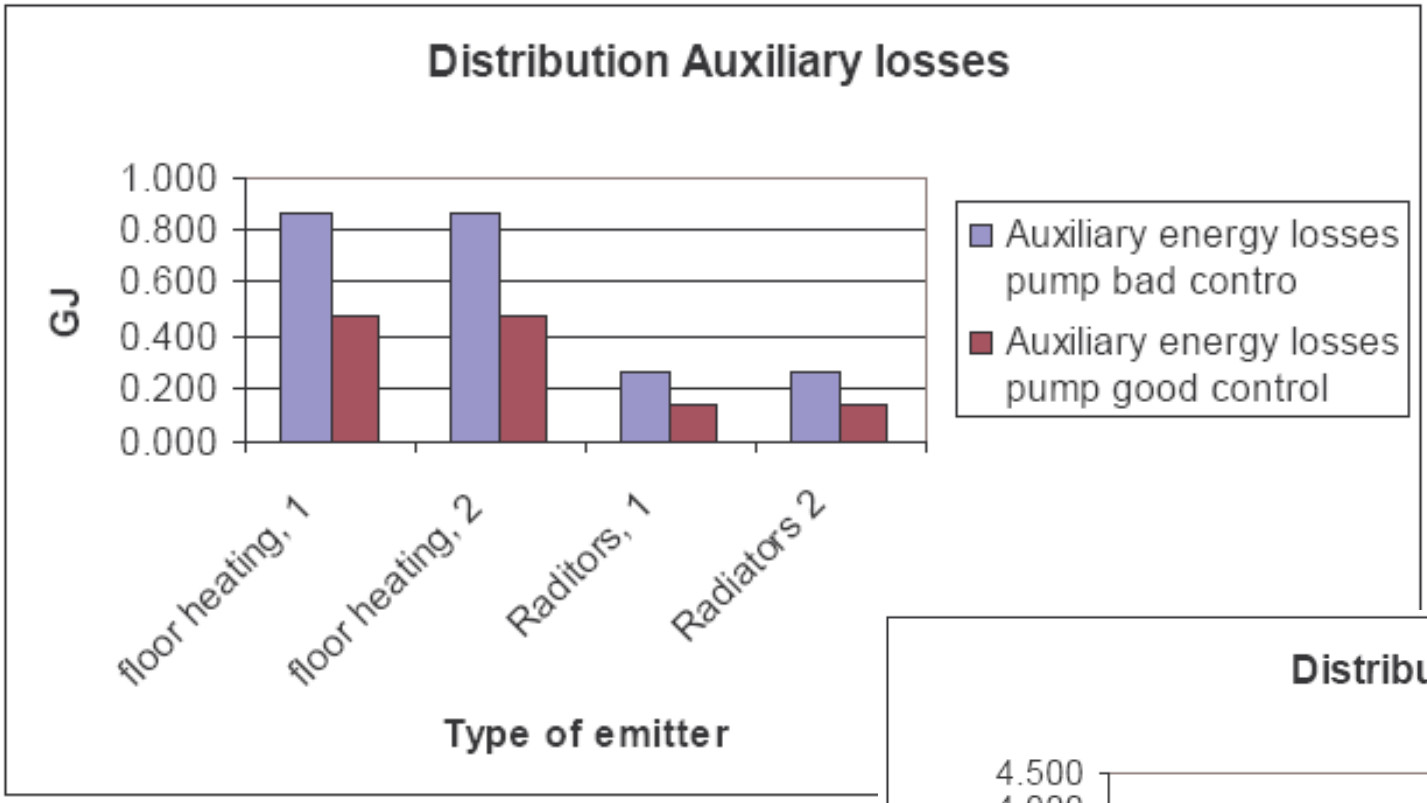
These internal temperatures are used in the calculations instead of the initial room temperature.

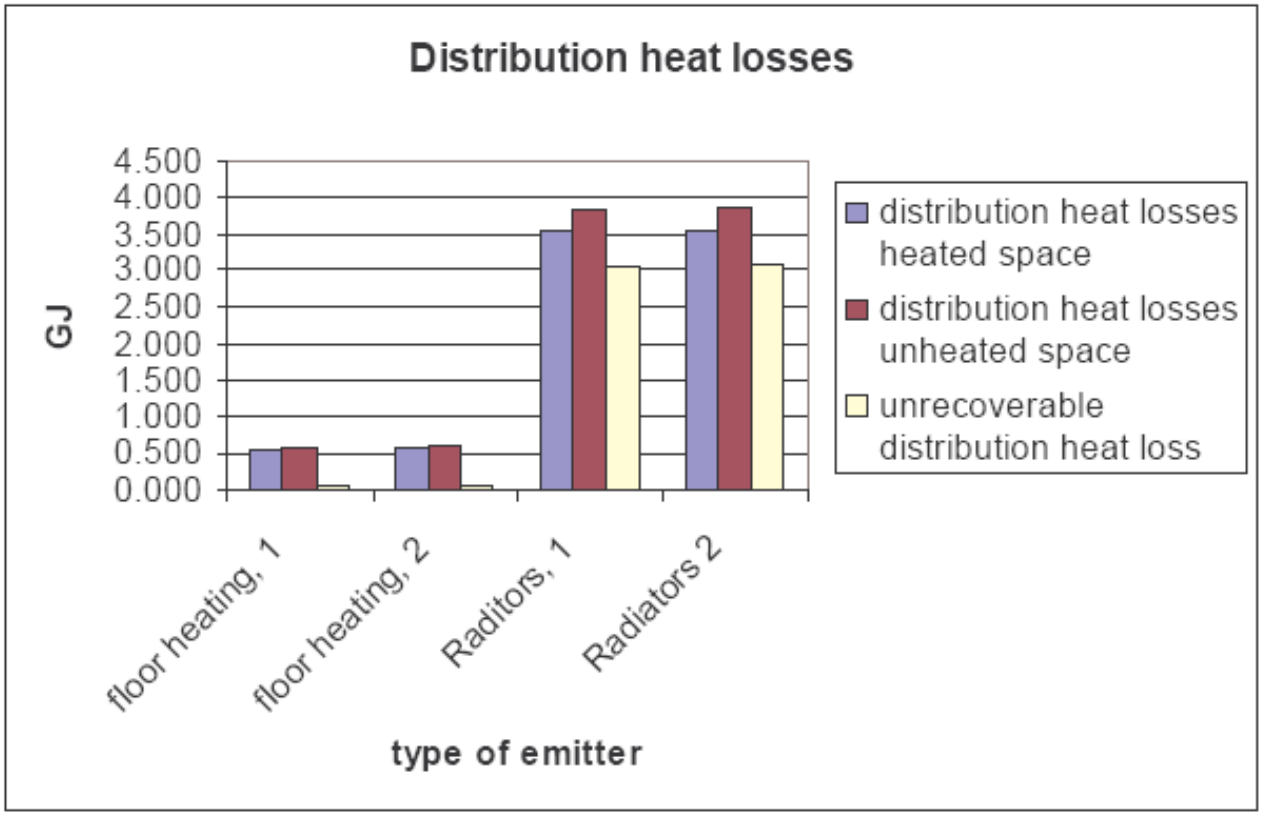
Emission Brussels

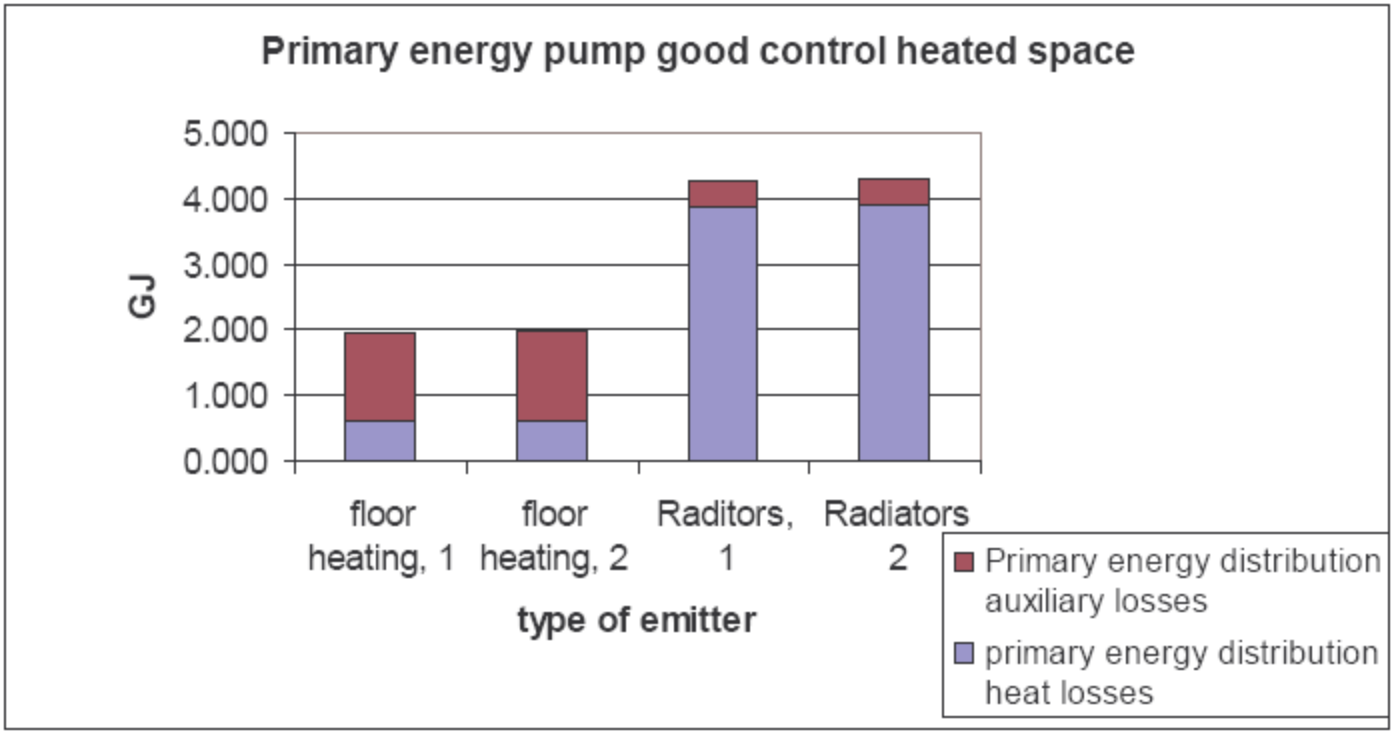


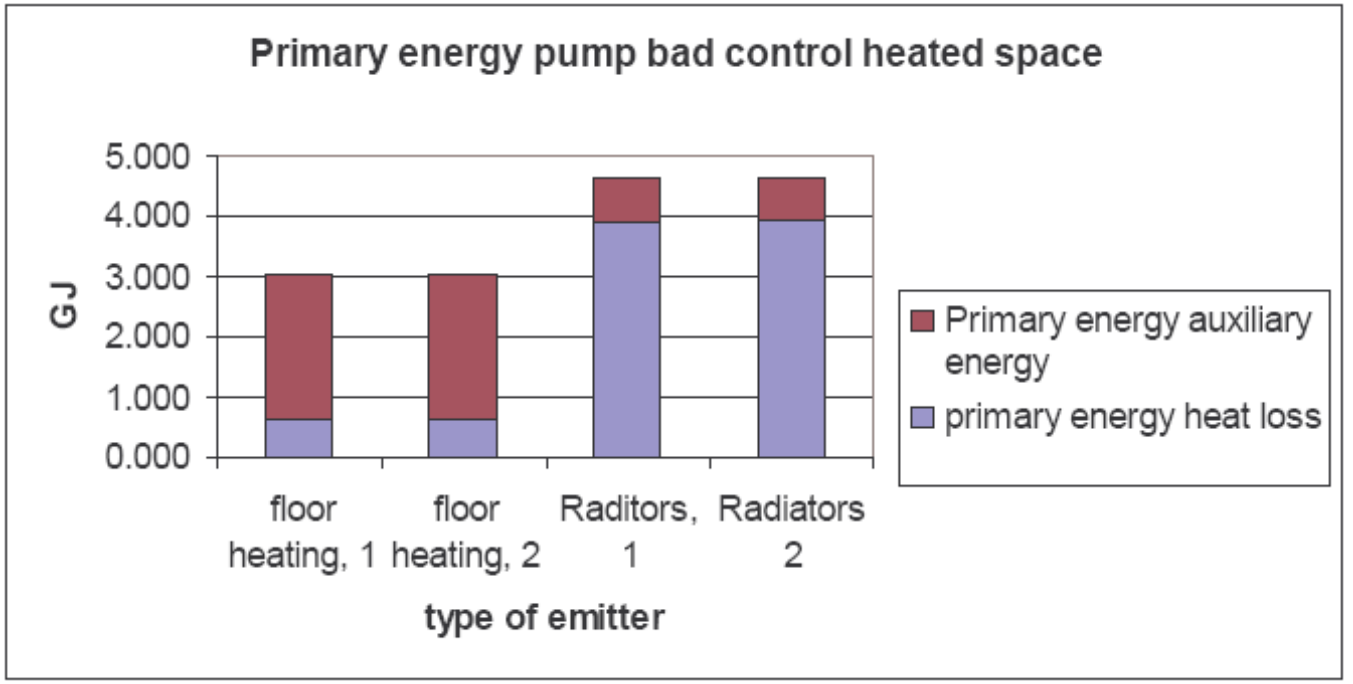
	1	2	3	4
Floor heating, case 1	116.787	112.383	116.570	122.120
Floor heating, case 2	117.935	116.570	118.664	122.120
Radiator, case 1	108.984	111.144	114.459	121.645
Radiator, case 2	110.063	115.332	116.553	121.645

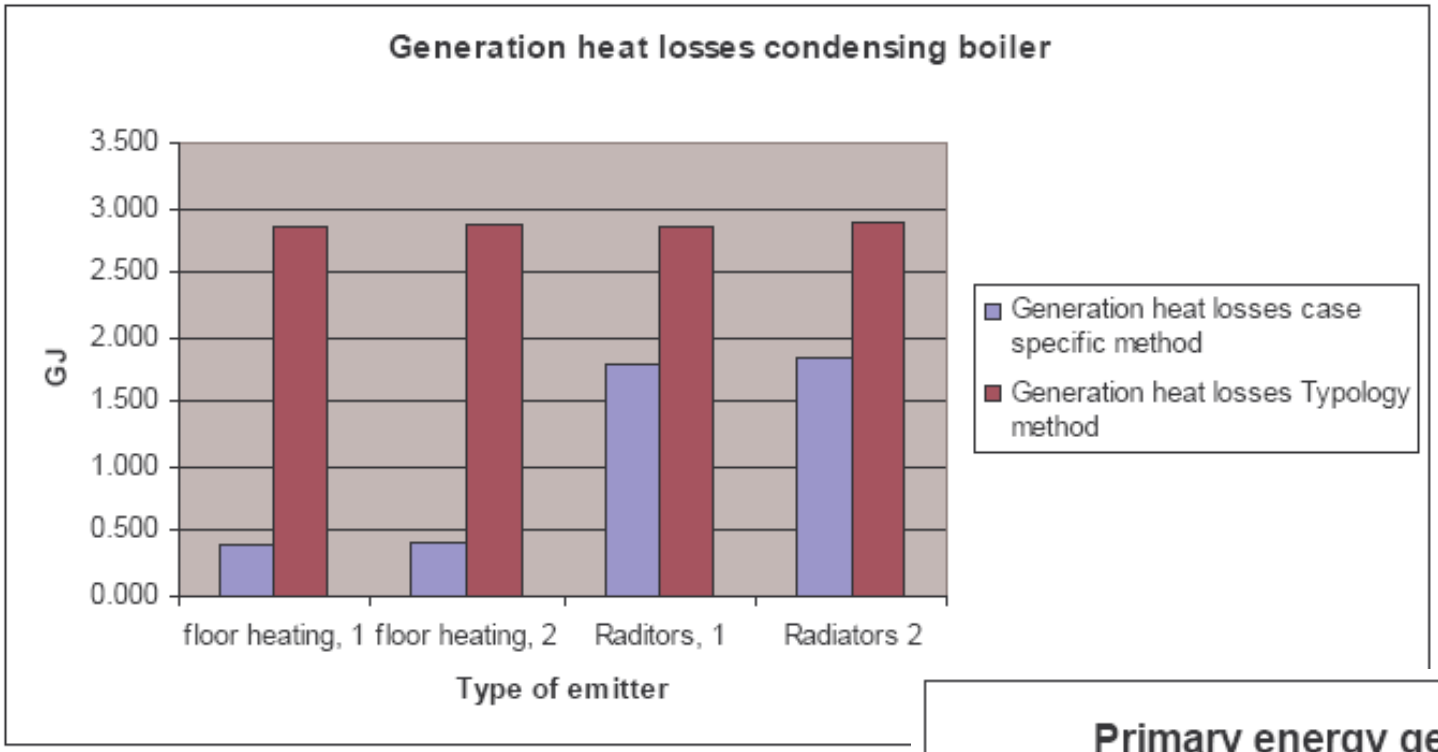
Type of calculation

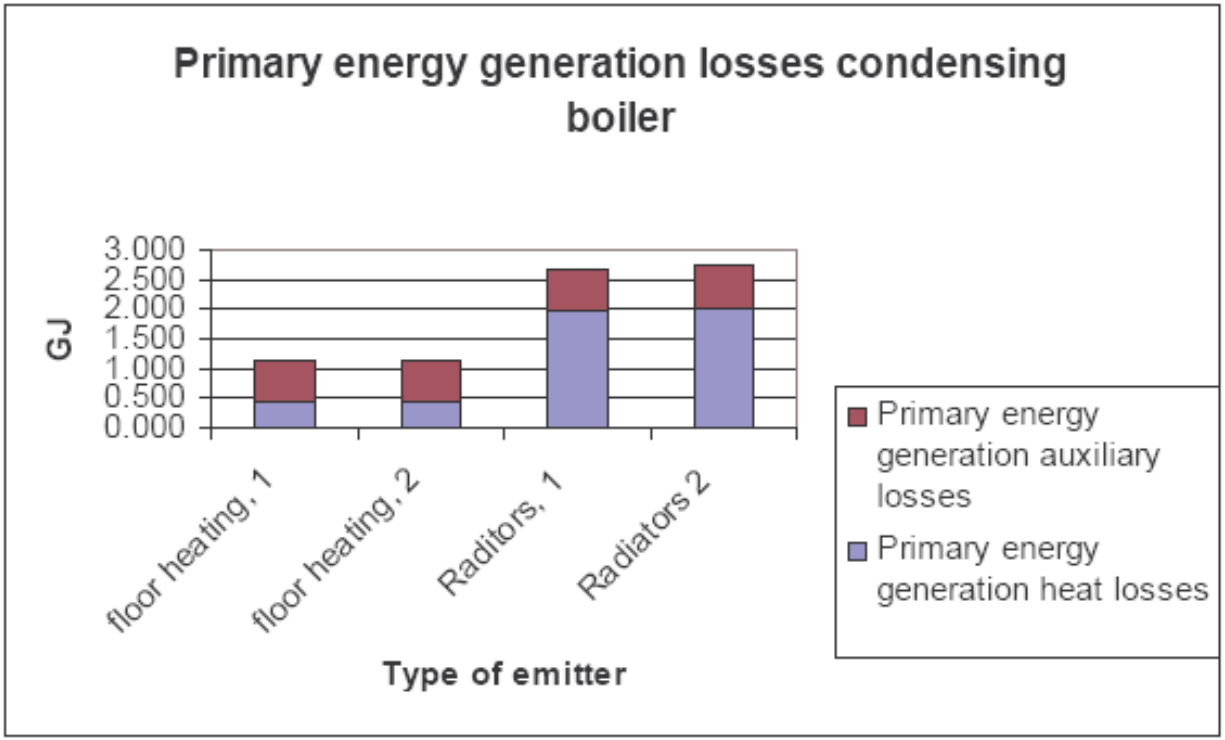

Distribution Auxiliary losses
1.000
0.800
0.600
0.400
0.200
0.000
GJ
floor heating, 1
floor heating, 2
Raditors, 1
Radiators 2
Type of emitter
Auxiliary energy losses pump bad contro
Auxiliary energy losses pump good control

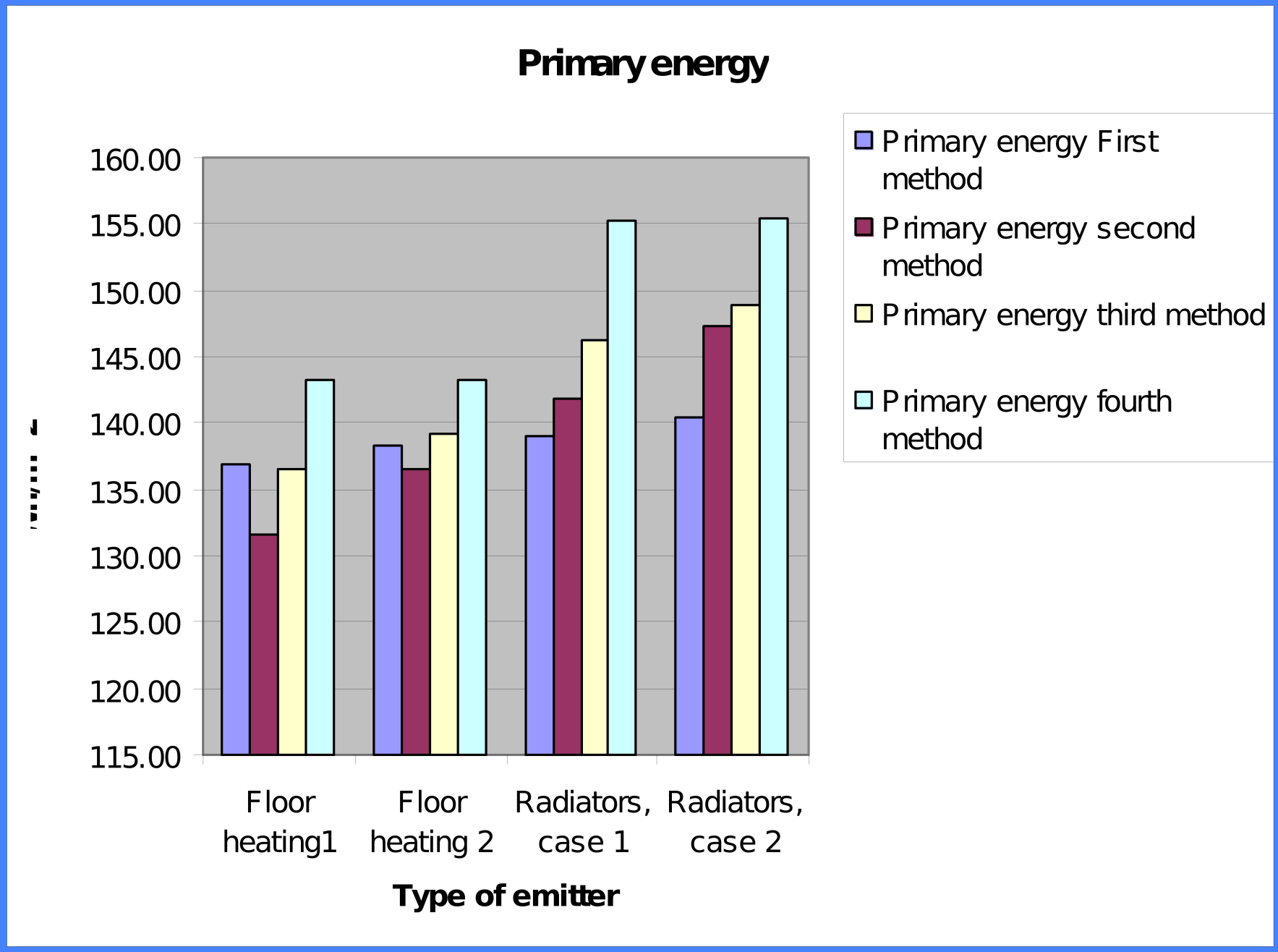

Distribution heat losses
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
GJ
floor heating, 1
floor heating, 2
Raditors, 1
Radiators 2
type of emitter
distribution heat losses heated space
distribution heat losses unheated space
unrecoverable distribution heat loss

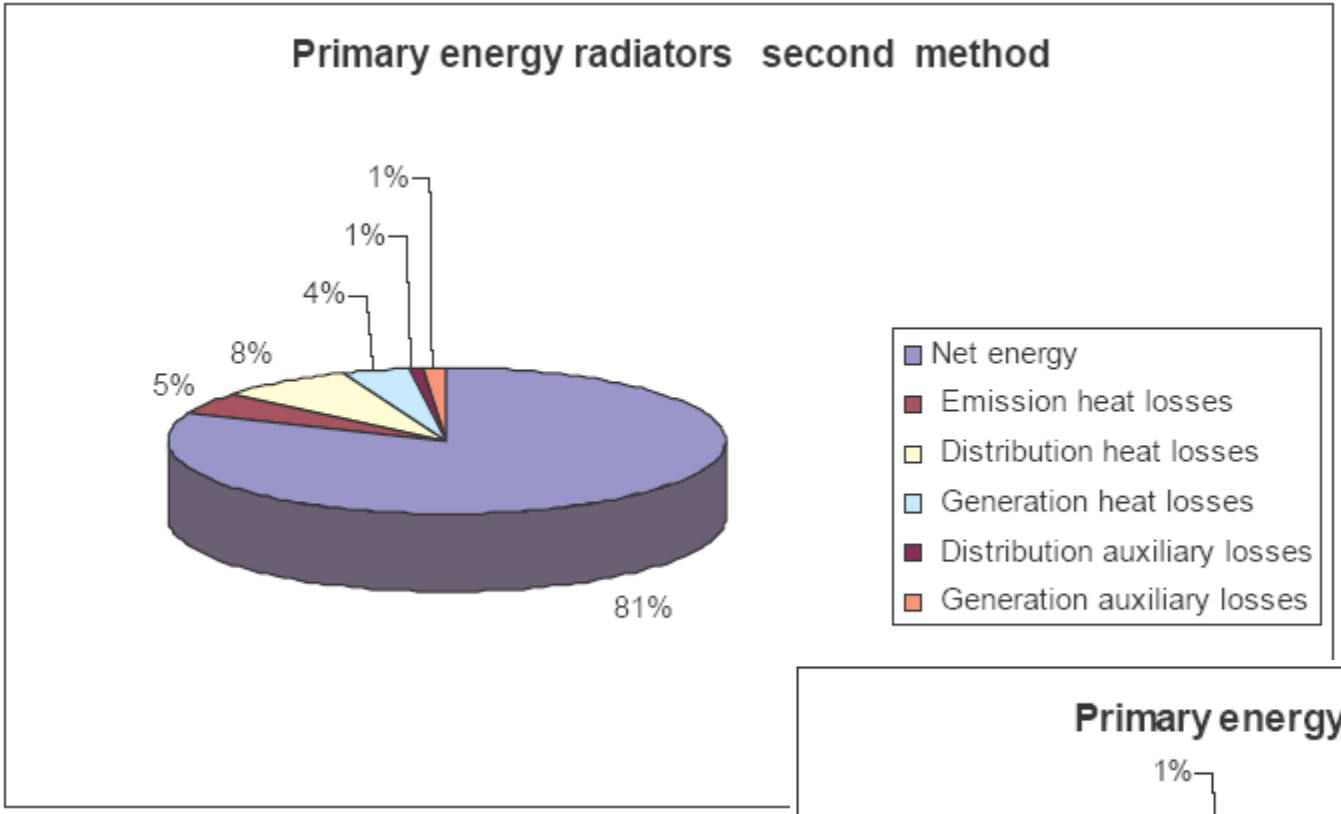

Primary energy pump good control heated space
5.000
4.000
3.000
2.000
1.000
0.000
GJ
floor heating, 1
floor heating, 2
Raditors, 1
Radiators 2
type of emitter
Primary energy distribution auxiliary losses
primary energy distribution heat losses

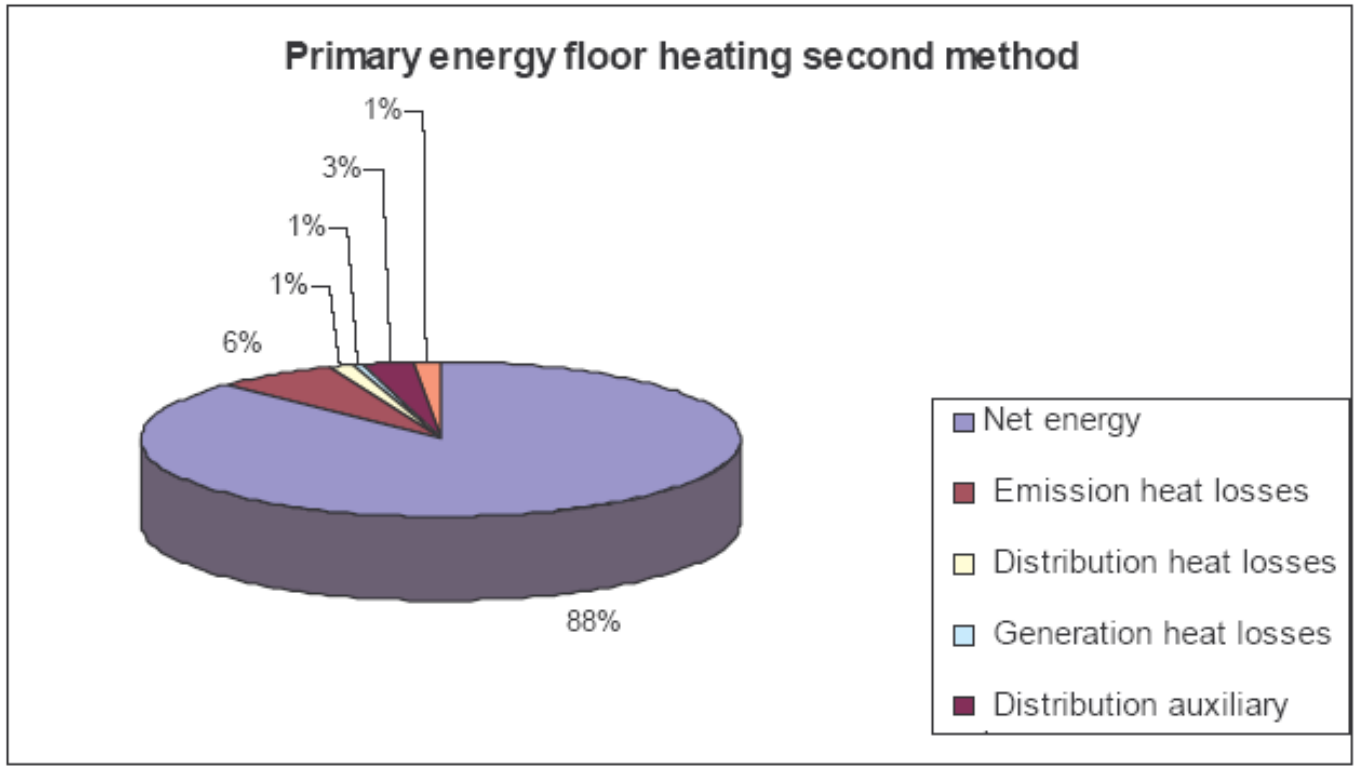

Primary energy pump bad control heated space
5.000
4.000
3.000
2.000
1.000
0.000
GJ
floor heating, 1
floor heating, 2
Raditors, 1
Radiators 2
type of emitter
Primary energy auxiliary energy
primary energy heat loss

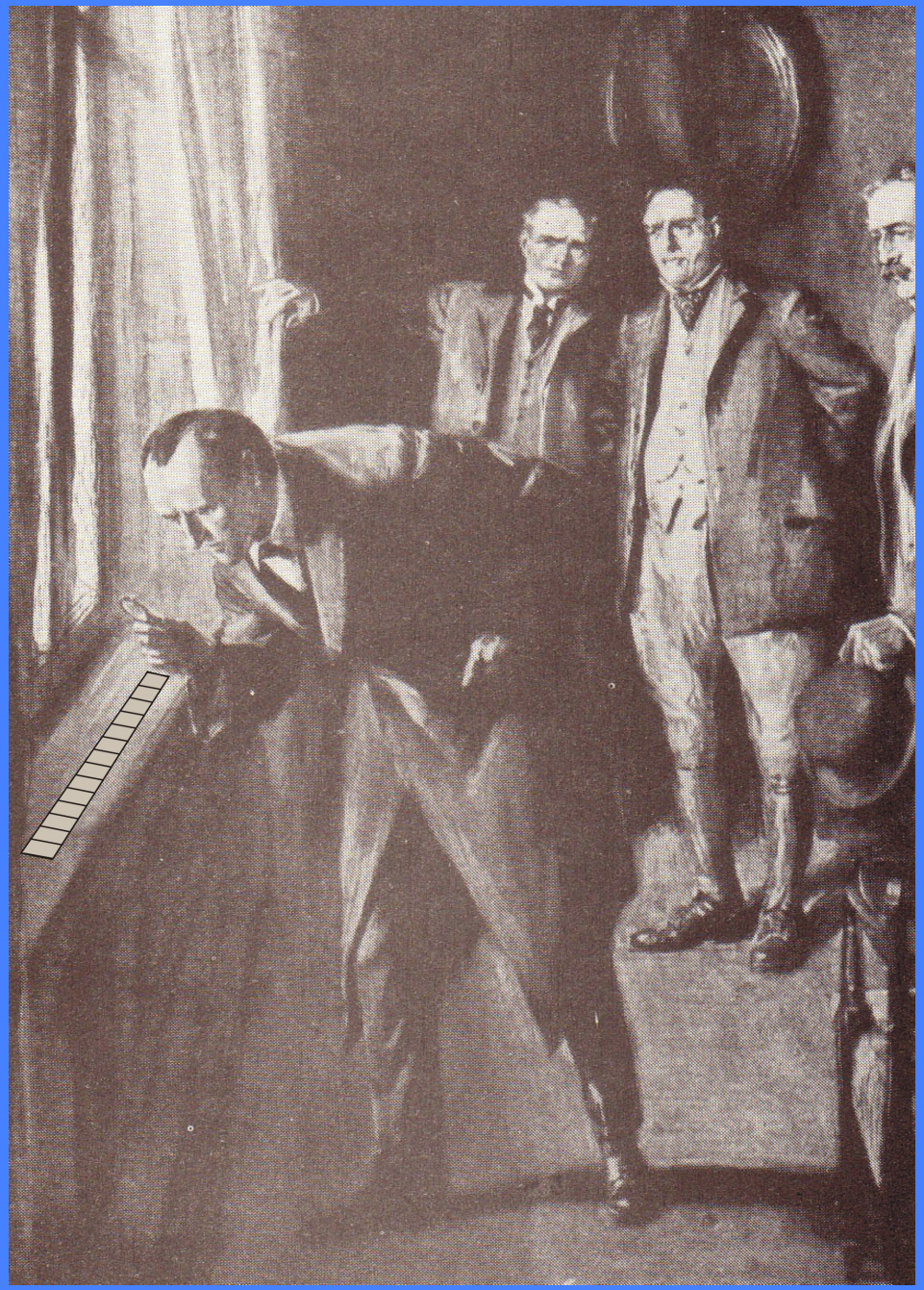

Generation heat losses condensing boiler
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
GJ
floor heating, 1
floor heating, 2
Raditors, 1
Radiators 2
Type of emitter
Generation heat losses case specific method
Generation heat losses Typology method


Primary energy generation losses condensing boiler
3.000
2.500
2.000
1.500
1.000
0.500
0.000
GJ
floor heating, 1
floor heating, 2
Raditors, 1
Radiators 2
Type of emitter
Primary energy generation auxiliary losses
Primary energy generation heat losses


Primary energy
160.00
155.00
150.00
145.00
140.00
135.00
130.00
125.00
120.00
115.00
Floor heating1
Floor heating 2
Radiators, case 1
Radiators, case 2
Type of emitter
Primary energy First method
Primary energy second method
Primary energy third method
Primary energy fourth method


Primary energy radiators second method
1%
1%
4%
8%
5%
81%
Net energy
Emission heat losses
Distribution heat losses
Generation heat losses
Distribution auxiliary losses
Generation auxiliary losses


Primary energy floor heating second method
1%
3%
1%
1%
6%
88%
Net energy
Emission heat losses
Distribution heat losses
Generation heat losses
Distribution auxiliary



INSPECTION

- Boiler and Heating System
- Ventilation System
- Air- (Room) Conditioning System

INSPECTION

- **Development of a standard inspection procedure**
  - **Boilers and heating systems**
  - **Ventilation systems**
  - **Cooling systems (Air or Room Conditioning)**
- **Education of inspectors**

IMPACT ON FUTURE ENERGY CONSUMPTION

- Directive do not set limits for energy consumption.
- National requirements
- But in 5 years with common methods the commission may require general reductions
- More emphasis on renewable energy sources

OPORTUNITIES FOR THE HVAC INDUSTRY

- **Earlier involvement in the building process**
- **More jobs (energy certificates, inspections, service)**

Objectives and measures

Objectives

- Promoting the improvement of energy performance of buildings within the EU through cost-effective measures.
- Convergence of building standards towards those of Member States which already have ambitious levels.

Proposed measures

- Methodology for integrated buildings energy performance standards.
- Application of these standards on new and existing buildings.
- Certification schemes for all buildings.
- Inspection & assessment of boilers/heating and cooling installations.